

Linking SARAH and MadGraph using the UFO format

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Abstract

SARAH is a Mathematica package optimized for the fast, efficient and precise study of supersymmetric models beyond the MSSM: a new model can be defined in a short form and all vertices are derived. This allows SARAH to create model files for **FeynArts/FormCalc**, **CalcHep/CompHep** and **WHIZARD/O'Mega**. The newest version of SARAH now provides the possibility to create model files in the UFO format which is supported by **MadGraph 5**, **MadAnalysis 5**, **GoSam**, and soon by **Herwig++**. Furthermore, SARAH also calculates the mass matrices, RGEs and 1-loop corrections to the mass spectrum. This information is used to write source code for **SPheno** in order to create a precision spectrum generator for the given model. This spectrum-generator-generator functionality as well as the output of **WHIZARD** and **CalcHep** model files have seen further improvement in this version.

1. Introduction

Supersymmetry (SUSY) is still one of the best-motivated extensions of the standard model (SM) of particle physics. Even the minimal supersymmetric standard model (MSSM) predicts many new particles [1, 2] and has been studied intensively for decades. However, so far no hint of any of these particles has been found at the LHC [3, 4, 5, 6, 7, 8]. On the other hand, there are indications for a Higgs mass of around 125 GeV [9, 10]. Even if this mass can be obtained within the MSSM or the constrained MSSM (CMSSM), the interest in non-minimal models has grown. Models with an extended Higgs sector can not only enhance the mass of the SM-like Higgs boson [11, 12, 13, 14, 15, 16, 17, 18, 19, 20], but also lead to a rich collider phenomenology [21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31] and possibly to new dark matter candidates [32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43]. Therefore, it is very interesting to study the phenomenological aspects of many extensions of the MSSM. However, many computer tools, such as those to calculate mass spectra or the dark matter relic density, or to perform collider studies, still support only the MSSM out of the box.

The Mathematica package **SARAH** was created to close this gap between model building and the usage of well-known computer tools to get precise numerical results for new models. The main idea of **SARAH** is that a new supersymmetric model can be easily and quickly implemented by just defining the gauge structure, particle content and superpotential, along with the gauge symmetry breaking and the corresponding field rotations. **SARAH** uses this information to derive the mass matrices, tadpole equations, renormalization group equations (RGEs) and vertices. Expressions for the 1-loop corrections to the 1- and 2-point functions are also calculated by **SARAH**. Since version 1.0, **SARAH** [44, 45, 46] has supported the output of the vertices to model files which can be used with **CalcHep/CompHep** [47, 48] as well as **FeynArts/FormCalc** [49, 50]. Support for **WHIZARD/O'Mega** [51, 52] was added in version 3.0.

In addition, **SARAH** has become the first available ‘spectrum - generator - generator’: all information derived by **SARAH** necessary for a 2-loop RGE evaluation and the calculation of the 1-loop corrected mass spectrum can be exported to **Fortran** code which can then be compiled with **SPheno** [53, 54] to generate a fully-fledged spectrum generator for a given model. This interface between **SPheno** and **SARAH** was the last missing link between model building and phenomenological studies. The **SUSY Toolbox** [55] combines all

the possible outputs of **SARAH** to create an environment for the study of SUSY models beyond the MSSM, consisting of the powerful public tools **SPheno**, **CalcHep**, **MicrOmegas** [56], **HiggsBounds** [57, 58], **WHIZARD** and **SSP**.

The newest version **SARAH 3.1** continues this development. The output of model files in the UFO (Universal FeynRules output) format [59] is now supported. Thus far, it has only been possible to create UFO model files in an automatized way by using **FeynRules** [60, 61, 62, 63]. This format can be read for example by **MadGraph 5** [64]. Hence it is now possible to study all models already implemented by **SARAH** also with **MadGraph**. Therefore, **MadGraph** has recently also become part of the **SUSY Toolbox**. In addition, there are other improvements in **SARAH 3.1**: the outputs for **SPheno**, **CalcHep** and **WHIZARD** have been amended, the **PDG.IX** scheme is supported and the handling of gauge fixing terms has been automatized. Finally, control files for the **LHPC Spectrum Plotter** can be written. In section 2, we present the UFO output of **SARAH** before we show the other improvements of the newest version in section 3.

2. Interfacing SARAH and MadGraph

SARAH can write model files in the UFO format to implement new models in **MadGraph 5**. This format is also supported by other tools like **GoSam** [65] or **MadAnalysis 5** [66], and soon by **Herwig++** [67, 68]. In general, the model files written by **SARAH** include the entire flavor and CP structure of the model. For a model which is already implemented in **SARAH**, it is rather easy to create the requested output by typing inside Mathematica

```
<< $SARAH/SARAH.m
Start["$MODEL"];
MakeUFO[Options];
```

The meaning of these three steps is the following: first, **SARAH** has to be loaded by using either the relative or absolute path **\$SARAH** to the **SARAH** installation. The second step is to initialize the requested model, for instance the MSSM via **\$MODEL = MSSM**. A list of all models which are delivered with the public version of **SARAH 3.1** is given in Appendix A or can be printed by **SARAH** using the command **ShowModels**. For a step-by-step explanation how to implement new models, we refer to Ref. [45] and [55].

During the initialization of a model **SARAH** calculates the entire Lagrangian density for the mass eigenstates as well as the mass matrices and tadpole equations. When this is finished, the routine to write the model files in the UFO format is called. Optional arguments can be used for this routine

- **Eigenstates** -> **\$NAME**: this defines for which set of eigenstates the model files should be written. For the models included in **SARAH**, **\$NAME** can either be **GaugeES** for the gauge eigenstates or **EWSB** for the mass eigenstates after electroweak symmetry breaking (EWSB). By default **EWSB** is used.
- **Exclude** -> **\$LIST**: to speed up the output and to keep the model files short it is possible to suppress the output of generic groups of vertices which are not needed. By default **\$LIST = {SSSS, GGS, GGV}** is used to exclude the scalar four point interactions and the ghost terms. The other possibilities are **SSS** (three scalar interactions), **SSV** (two scalar - one vector boson interactions), **SVV** (one scalar - two vector boson interactions), **SSVV** (two scalar - two vector boson interactions), **FFS** (two fermion - one scalar interactions), **FFV** (two fermion - one vector boson interactions), **VVV** (three vector boson interactions), and **VVVV** (four vector boson interactions).

The output written by **SARAH** consists of the files

- **particles.py**: contains the particles present in the model
- **parameters.py**: contains all parameters present in the model
- **lorentz.py**: defines the Lorentz structures needed for the vertices
- **vertices.py**: defines the vertices

- `couplings.py`: expressions to calculate the couplings

These files are saved in the directory

`$SARAH/Output/$MODEL/$EIGENSTATES/UFO/`

This directory contains also additional files which are model independent and can therefore be used with all models: `function_library.py`, `object_library.py`, `__init__.py` and `write_param_card.py`. These files were kindly provided by Olivier Mattelaer.

To use the model files with **MadGraph 5**, it is sufficient to copy all files to `$MADGRAPH/models/$NAME`. Here, `$MADGRAPH` is the directory containing the local **MadGraph** installation and `$NAME` is a freely-chosen name of a new subdirectory. This directory name is used afterwards to load the model in **MadGraph** via

```
import model $NAME
```

MadGraph has a list of pre-defined names for the particles of the SM and MSSM which are used by default. However, it could be that there are conflicts between these names and the names used by **SARAH** in an extension of the MSSM. For instance, `h3` is defined in **MadGraph** as the pseudoscalar Higgs in the MSSM, but **SARAH** uses it in the NMSSM for the third-heaviest scalar Higgs. In order to avoid such clashes, a model can be loaded using only the names defined by the UFO files via

```
import model $NAME -modelname
```

To use these model files for the calculation of cross sections, it is, of course, necessary to provide the numerical values of all masses and parameters. The necessary input can be obtained by using a **SPheno** module created by **SARAH** for the given model, see also section 3.1. The SLHA spectrum files written by this **SPheno** module can directly be used with **MadGraph**. In this way, the chain **SARAH**– **SPheno**– **MadGraph** provides a direct link from model building to collider phenomenology.

Validation. To validate the model files written by **SARAH** in the UFO format, a list of $1 \rightarrow 2$ decays and $2 \rightarrow 2$ processes was calculated using **MadGraph 5.1.4.6**. The results were compared with those calculated with the MSSM model files delivered with **MadGraph**. For all $1 \rightarrow 2$ decays there was always an exact numerical agreement. The results for the $2 \rightarrow 2$ scattering are shown in Appendix B. It can be seen that all observed differences are smaller than the numerical error.

3. Other new features and improvements in SARAH 3.1

3.1. SPheno output

SARAH can use all derived information about a supersymmetric model to write **Fortran** source code. This code can be compiled with **SPheno** and modules for new models are created without the need to write any line of source code by hand. The features of the **SPheno** modules written by **SARAH** are a precise calculation of the mass spectrum using 2-loop RGEs, and 1-loop corrections to all masses. In addition, routines are written to calculate the decay widths and branching ratios for SUSY and Higgs particles. Also the calculation of a set of electroweak precision observables is included. All calculations are done with the most general CP and flavor structure. This functionality of **SARAH** has been checked against existing spectrum calculators for the MSSM, see Ref. [55], and for the NMSSM, a comparison with **NMSSM-Tools** was done [74]. However, the **SPheno** output works also for more complicated models like the minimal SUSY $B - L$ model [69], left-right symmetric models [70, 71] or models with inverse seesaw mechanism [72, 73]. To output the **SPheno** code, the command

```
MakeSPheno[Options];
```

has to be used after starting the model. The different options are

- `ReadLists -> True/False`: if the vertices and RGEs for the given model have already been calculated, these results can be used and a new calculation is skipped. The default value is `False`.

- **Eigenstates** -> **\$NAME** : the name of the eigenstates for which the **SPheno** code should be written. The default value is **EWSB**.
- **InputFile** -> **\$FILENAME**: basic properties of the **SPheno** version such as boundary conditions at the GUT scale are defined in a separate file. The default name for that file is **SPheno.m**.
- **TwoLoop** -> **True/False**: defines if the 2-loop RGEs should be calculated and included in the **Fortran** code. The default value is **True**.
- **StandardCompiler** -> **\$COMPILER**: **SARAH** writes a makefile to compile the generated code together with an existing **SPheno** installation. The standard compiler defined in the makefile is usually **gfortran** but can be changed by this flag.

For more information in general about the **SPheno** output of **SARAH**, we refer the interested reader to Ref. [55]. The main improvements of the **SPheno** output are in the calculation of the low energy observables and of the decay widths. **SPheno** modules written by previous versions of **SARAH** calculate $\delta\rho$, $b \rightarrow s\gamma$, $l_i \rightarrow l_j\gamma$, $l_i \rightarrow 3l_j$, $a_{e,\mu,\tau}$ and the electric dipole moments of the charged leptons. This list has been extended now by

- $\mu - e$ conversion in nuclei (Al, Ti, Sr, Sb, Au, Pb) based on the results of [75]
- $\tau \rightarrow lP^0$ with a pseudoscalar meson P^0 (π^0 , η , η') based on the results of [76]
- $Z \rightarrow l_i l_j$ calculated and implemented by Kilian Nickel [77]

We want to pronounce that similar to the previously implemented calculation of $l_i \rightarrow 3l_j$ also for $\mu - e$ conversion and τ into meson decays not only the photonic contributions are included. Those are often assumed to be dominant, however, it has been shown recently that especially the Z can be very important in extensions of the MSSM and have to be taken into account [78, 77, 73], but also the Higgs penguins can give sizable contributions [79]. Therefore, in all calculations the possible contributions of Z and Higgs penguins as well as box diagrams are taken into account.

In addition, the calculation of all decays has been improved by performing an RGE evaluation of all couplings from the SUSY scale to the mass scale of the decaying particle. Previously, the values of the parameters at the SUSY scale were used in all decays. Furthermore, the calculation of the loop-induced decays of a Higgs particle into two photons and two gluons includes now also the dominant QCD corrections based on the results given in Ref. [80].

3.2. Gauge fixing terms

If ghost vertices were to be calculated by previous versions of **SARAH**, it used to be necessary to define the gauge fixing terms in R_ξ gauge. However, the new version of **SARAH** derives these terms automatically using the calculated kinetic terms of the Lagrangian. To this end, the condition is applied that the mixing between scalar particles and vector bosons vanishes. Afterwards, the derived gauge fixing terms are used to calculate the ghost interactions.

Since it can happen in models with an extended gauge sector that several Goldstone bosons are a mixture of the same gauge eigenstate, for each massive vector boson, the corresponding Goldstone boson has to be defined

```
{ { Description -> "Z-Boson",
    ...
    Goldstone -> Ah[{1}]} },
...
{ { Description -> "Z'-Boson",
    ...
    Goldstone -> Ah[{2}]} },
```

3.3. Output for CalcHep and WHIZARD

CalcHep. CalcHep is able to read the numerical values of the masses and mixing matrices from a SLHA spectrum file or to take the values defined in the variable file; as an alternative, the **SLHA+** functionality [81] added routines to CalcHep to diagonalize mass matrices to obtain the eigenvalues and eigenvectors by itself. Therefore, we have implemented in SARAH the option to include the mass matrices of a given value in the CalcHep model files and to parametrize all vertices by the rotation matrices calculated internally by CalcHep. To use this possibility, the CalcHep output has to be started via

```
CHep[SLHAinput->False, CalculateMasses->True];
```

The first option has to be used to disable the default approach that all masses and rotation matrices are taken from a SLHA spectrum file. The second option is used to write the necessary routines to the CalcHep files to diagonalize all mass matrices. If this option were also set to **False**, the masses and rotation matrices would be expected to be given in the variables file (`varsX.mdl`) of CalcHep.

Another, small improvement in the CalcHep output is that SARAH now adds the electric charge of all particles in the **Aux** column of the particle list. This is especially helpful for models with an extended gauge sector because CalcHep might not be able to derive this information on its own.

WHIZARD. The speed of the WHIZARD output has been improved significantly: to write the model files for the MSSM, the running time has been reduced by more than a factor of 2 (from 12.2 to 5.0 minutes)¹. For a more involved model like the $B - L$ -SSM, the speed improvement is even larger (from 6.9 to 1.3 hours).

3.4. Generalized PDG numbering scheme

Recently, a generalized PDG numbering scheme (PDG.IX) was proposed which might be more suitable, especially for extensions of the SM which include many new particles [82, 83]. The basic idea is that the main properties of all particles (SM/Non-SM, spin, CP character, $B - L$ quantum number, electric charge, $SU(3)_C$ transformation) are encoded in a nine digit number. This provides not only information about the particles but fixes also the PDG particle code of new particles and hopefully prevents the use of randomly chosen numbers, and the confusion that this can cause. Therefore, it is now possible to define two different PDGs for a given particle in the model files in SARAH:

```
{ { Description -> "Gluino",  
  ...  
  PDG -> {1000021},  
  PDG.IX -> {211110001}  
  ...  
  } },
```

By default, the entries of PDG are used. To switch to the new scheme, either at the beginning of a SARAH session or in the model files, the following statement has to be added:

```
UsePDGIX = True;
```

3.5. Output for LHPC Spectrum Plotter

The LHPC spectrum plotter by Ben O’Leary can produce plots of the SUSY mass spectrum based on the information given in a SLHA output file. The repository is available at

https://github.com/benoleary/LesHouchesParserClasses_CPP

¹Time taken on a Lenovo Thinkpad X220 with 2.53 GHz

For the output it is necessary to provide a second control file in addition to the SLHA spectrum file. The control file includes information about the paths to the necessary shell tools (`gnuplot`, `latex`, `dvips`, `ps2eps`, `rm`, `mv`) and the L^AT_EX name associated with a PDG number. In addition, the color and column used for the different particles are defined in that file. **SARAH** can provide such a file which works nicely together with the spectrum file written by a **SPheno** module also created by **SARAH**. By default it assumes the standard paths under Linux, while the color and column of each particle can be defined in `particles.m` using the new option `LHPC`. For instance, to put the gluino in the fourth column and to use purple for the lines, the entry reads

```
{ { Description -> "Gluino",
    ...
    LaTeX -> "\\tilde{g}",
    LHPC -> {4, "purple"},
    ... } },
```

As name for the colors all available colors in `gnuplot` can be used. The control file for a given set of eigenstates of the initialized model is written via

```
MakeLHPCstyle[$EIGENSTATES];
```

and saved in the directory

```
$SARAH/Output/$MODEL/$EIGENSTATES/LHPC/
```

It is used together with a spectrum file to create the figure by the shell command

```
./LhpcSpectrumPlotter.exe SPheno.spc.$MODEL LHPC_$MODEL_Control.txt
```

3.6. Calculation of RGEs

The calculation of 2-loop RGEs for models with many new interactions can be very time-consuming. However, often one is only interested in the dominant effects of the new contributions at the 1-loop level. Therefore, a new option to the command `CalcRGEs` has been added to ignore specific parameters in the calculation of the 2-loop RGEs

```
CalcRGEs[IgnoreAt2Loop -> $LIST];
```

Here, `$LIST` contains the parameters (superpotential, soft SUSY-breaking or gauge couplings) which should not be taken into account at 2-loop.

4. Conclusion

We have presented the improvements in the new version of the Mathematica package **SARAH**. **SARAH** was created to simplify the study of SUSY models beyond the MSSM and supported in earlier version the output of model files for **FeynArts**/**FormCalc**, **CalcHep**/**CompHep**, and **WHIZARD**/**O'Mega** as well as the source code output for **SPheno**. In addition, the new version of **SARAH** includes also model files in the UFO format which can be read by **MadGraph 5**. This significantly extends the list of SUSY models which can be studied with **MadGraph** at the moment. In this context, **MadGraph 5** has also been added to the **SUSY Toolbox**.

We have also shown that the handling of gauge fixing terms has been significantly simplified in **SARAH** and the generalized PDG numbering scheme `PDG.IX` can now be used optionally. Furthermore, the speed of the **WHIZARD** output has been improved and the **CalcHep** output includes the possibility to diagonalize the mass matrices internally. The calculation of the decay widths and branching ratios in the **SPheno** output has been improved and the list of calculated low energy constraints has been extended. Finally, **SARAH** can write control files for the **LHPC Spectrum Plotter**.

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Appendix A. Models

In **SARAH 3.1** the following models are included:

- Minimal supersymmetric standard model:
 - With general flavor and CP structure (**MSSM**)
 - Without flavor violation (**MSSM/NoFV**)
 - With explicit CP violation in the Higgs sector (**MSSM/CPV**)
 - In SCKM basis (**MSSM/CKM**)
- Singlet extensions:
 - Next-to-minimal supersymmetric standard model (**NMSSM**, **NMSSM/NoFV**, **NMSSM/CPV**, **NMSSM/CKM**)
 - near-to-minimal supersymmetric standard model (**near-MSSM**)
 - General singlet extended, supersymmetric standard model (**SMSSM**)
- Triplet extensions
 - Triplet extended MSSM (**TMSSM**)
 - Triplet extended NMSSM (**TNMSSM**)
- Models with R -parity violation
 - bilinear RpV (**MSSM-RpV/Bi**)
 - Lepton number violation (**MSSM-RpV/LnV**)
 - Only trilinear lepton number violation (**MSSM-RpV/TriLnV**)
 - Baryon number violation (**MSSM-RpV/BnV**)
 - $\mu\nu$ SSM (**munuSSM**)
- Additional $U(1)$ ’s
 - $U(1)$ -extended MSSM (**UMSSM**)
 - secluded MSSM (**secluded-MSSM**)
 - minimal $B - L$ model (**B-L-SSM**)
 - minimal singlet-extended $B - L$ model (**N-B-L-SSM**)
- SUSY-scale seesaw extensions
 - inverse seesaw (**inverse-Seesaw**)
 - linear seesaw (**LinSeesaw**)
 - singlet-extended inverse seesaw (**inverse-Seesaw-NMSSM**)
 - inverse seesaw with $B - L$ gauge group (**B-L-SSM-IS**)
 - minimal $U(1)_R \times U(1)_{B-L}$ model with inverse seesaw (**BLRinvSeesaw**)

- High-scale extensions
 - Seesaw 1 - 3 ($SU(5)$ version), (`Seesaw1`,`Seesaw2`,`Seesaw3`)
 - Left/right model (Ω LR) (`Omega`)
- Non-SUSY models:
 - SM (`SM`, `SM/CKM`)
 - inert doublet model (`Inert`)

Appendix B. Validation of UFO output

Cross section and numerical error calculated with `MadGraph 5` using the model files for the MSSM included in `MadGraph 5.1.4.6` (σ_M , δ_M) and UFO model files written by `SARAH` (σ_S , δ_S). The difference was calculated as $\Delta = (\sigma_S - \sigma_M)/\sigma_S$.

Process	σ_S [fb]	δ_S [%]	σ_M [fb]	δ_M [%]	Δ [%]
$e\bar{e} \rightarrow \tilde{e}_1 \tilde{e}_1^*$	4.461×10^{-3}	4.32×10^{-4}	4.46×10^{-3}	3.42×10^{-4}	4.14×10^{-5}
$e\bar{e} \rightarrow \tilde{e}_2 \tilde{e}_2^*$	1.508×10^{-4}	6.78×10^{-4}	1.509×10^{-4}	7.62×10^{-4}	-3.12×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_3 \tilde{e}_3^*$	1.319×10^{-4}	6.73×10^{-4}	1.319×10^{-4}	7.52×10^{-4}	-1.87×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_4 \tilde{e}_4^*$	4.595×10^{-3}	2.9×10^{-4}	4.594×10^{-3}	3.16×10^{-4}	1.83×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_5 \tilde{e}_5^*$	1.352×10^{-4}	6.84×10^{-4}	1.352×10^{-4}	7.71×10^{-4}	-3.85×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_6 \tilde{e}_6^*$	1.45×10^{-4}	6.91×10^{-4}	1.45×10^{-4}	7.78×10^{-4}	-2.97×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_3 \tilde{e}_6^*$	4.566×10^{-6}	3.03×10^{-4}	4.565×10^{-6}	3.46×10^{-4}	2.19×10^{-4}
$e\bar{e} \rightarrow \tilde{e}_1 \tilde{e}_4^*$	1.666×10^{-4}	1.11×10^{-3}	1.665×10^{-4}	1.22×10^{-3}	3.21×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_1 \tilde{u}_1^*$	2.713×10^{-4}	6.1×10^{-4}	2.714×10^{-4}	6.88×10^{-4}	-2.21×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_2 \tilde{u}_2^*$	2.713×10^{-4}	6.1×10^{-4}	2.714×10^{-4}	6.88×10^{-4}	-2.21×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_3 \tilde{u}_3^*$	1.686×10^{-4}	7.23×10^{-4}	1.686×10^{-4}	8.07×10^{-4}	-1.78×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_4 \tilde{u}_4^*$	1.787×10^{-4}	6.85×10^{-4}	1.788×10^{-4}	7.77×10^{-4}	-3.75×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_5 \tilde{u}_5^*$	1.787×10^{-4}	6.85×10^{-4}	1.788×10^{-4}	7.77×10^{-4}	-3.75×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_6 \tilde{u}_6^*$	2.035×10^{-4}	6.48×10^{-4}	2.035×10^{-4}	7.38×10^{-4}	-1.67×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_6 \tilde{u}_3^*$	3.939×10^{-5}	3.03×10^{-4}	3.938×10^{-5}	3.46×10^{-4}	2.03×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0$	6.317×10^{-4}	7.62×10^{-4}	6.319×10^{-4}	8.53×10^{-4}	-3.29×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_2^0$	2.342×10^{-4}	8.43×10^{-4}	2.342×10^{-4}	8.44×10^{-4}	-1.29×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_3^0$	1.325×10^{-5}	7.18×10^{-4}	1.325×10^{-5}	6.17×10^{-4}	6.42×10^{-5}
$e\bar{e} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_4^0$	3.09×10^{-5}	1.11×10^{-3}	3.089×10^{-5}	7.16×10^{-4}	2.45×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_2^0$	4.207×10^{-4}	8.02×10^{-4}	4.207×10^{-4}	8.08×10^{-4}	9.79×10^{-5}
$e\bar{e} \rightarrow \tilde{\chi}_3^0 \tilde{\chi}_3^0$	1.044×10^{-7}	4.32×10^{-4}	1.044×10^{-7}	4.63×10^{-4}	-4.39×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_4^0 \tilde{\chi}_3^0$	2.072×10^{-4}	1.59×10^{-4}	2.071×10^{-4}	1.63×10^{-4}	2.53×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_4^0$	6.382×10^{-5}	8.15×10^{-4}	6.387×10^{-5}	8.13×10^{-4}	-6.67×10^{-4}
$e\bar{e} \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-$	1.017×10^{-3}	8.45×10^{-4}	1.019×10^{-3}	9.27×10^{-4}	-1.7×10^{-3}
$e\bar{e} \rightarrow \tilde{\chi}_2^+ \tilde{\chi}_2^-$	5.815×10^{-4}	7.16×10^{-4}	5.816×10^{-4}	7.9×10^{-4}	-7.79×10^{-5}
$e\bar{e} \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_2^-$	8.138×10^{-5}	6.45×10^{-4}	8.138×10^{-5}	$7. \times 10^{-4}$	-4.92×10^{-5}
$e\bar{e} \rightarrow \tilde{\chi}_1^- \tilde{\chi}_2^+$	8.139×10^{-5}	6.45×10^{-4}	8.14×10^{-5}	6.95×10^{-4}	-1.72×10^{-4}
$e\bar{e} \rightarrow \tilde{u}_3 \tilde{u}_6^*$	3.939×10^{-5}	3.03×10^{-4}	3.938×10^{-5}	3.46×10^{-4}	2.03×10^{-4}
$e\bar{e} \rightarrow A^0 h$	8.357×10^{-9}	3.46×10^{-4}	8.359×10^{-9}	3.31×10^{-4}	-2.87×10^{-4}
$e\bar{e} \rightarrow h Z$	6.223×10^{-5}	3.46×10^{-4}	6.225×10^{-5}	3.31×10^{-4}	-2.89×10^{-4}
$e\bar{e} \rightarrow A^0 H$	4.804×10^{-5}	3.46×10^{-4}	4.806×10^{-5}	3.31×10^{-4}	-2.91×10^{-4}
$e\bar{e} \rightarrow H^- H^+$	1.502×10^{-4}	6.79×10^{-4}	1.503×10^{-4}	7.65×10^{-4}	-3.79×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_1 \tilde{d}_1^*$	1.834×10^{-4}	4.18×10^{-4}	1.835×10^{-4}	5.02×10^{-4}	-3.38×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_2 \tilde{d}_2^*$	1.834×10^{-4}	4.18×10^{-4}	1.835×10^{-4}	5.02×10^{-4}	-3.38×10^{-4}
$e\bar{e} \rightarrow W^- W^+$	3.157×10^{-2}	2.16×10^{-3}	3.16×10^{-2}	2.38×10^{-3}	-8.93×10^{-4}

$e\bar{e} \rightarrow \tilde{d}_3\tilde{d}_3^*$	1.479×10^{-4}	4.32×10^{-4}	1.479×10^{-4}	5.38×10^{-4}	-4.8×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_4\tilde{d}_4^*$	4.468×10^{-5}	6.85×10^{-4}	4.47×10^{-5}	7.76×10^{-4}	-3.63×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_5\tilde{d}_5^*$	4.468×10^{-5}	6.85×10^{-4}	4.47×10^{-5}	7.76×10^{-4}	-3.63×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_6\tilde{d}_6^*$	4.183×10^{-5}	7.13×10^{-4}	4.183×10^{-5}	8.02×10^{-4}	-1.33×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_3\tilde{d}_6^*$	1.938×10^{-5}	3.03×10^{-4}	1.937×10^{-5}	3.46×10^{-4}	2.06×10^{-4}
$e\bar{e} \rightarrow \tilde{d}_6\tilde{d}_3^*$	1.938×10^{-5}	3.03×10^{-4}	1.937×10^{-5}	3.46×10^{-4}	2.06×10^{-4}
$d\bar{d} \rightarrow \tilde{e}_2\tilde{e}_2^*$	2.056×10^{-5}	4.43×10^{-4}	2.057×10^{-5}	5.33×10^{-4}	-4.04×10^{-4}
$d\bar{d} \rightarrow \tilde{e}_3\tilde{e}_3^*$	4.015×10^{-6}	5.62×10^{-4}	4.016×10^{-6}	6.36×10^{-4}	-2.74×10^{-4}
$d\bar{d} \rightarrow \tilde{e}_4\tilde{e}_4^*$	5.007×10^{-6}	4.85×10^{-4}	5.008×10^{-6}	5.98×10^{-4}	$-2. \times 10^{-4}$
$d\bar{d} \rightarrow \tilde{e}_5\tilde{e}_5^*$	5.007×10^{-6}	4.85×10^{-4}	5.008×10^{-6}	5.98×10^{-4}	$-2. \times 10^{-4}$
$d\bar{d} \rightarrow \tilde{e}_6\tilde{e}_6^*$	1.709×10^{-5}	4.96×10^{-4}	1.709×10^{-5}	5.6×10^{-4}	-8.78×10^{-5}
$d\bar{d} \rightarrow \tilde{e}_3\tilde{e}_6^*$	2.234×10^{-6}	3.03×10^{-4}	2.234×10^{-6}	3.46×10^{-4}	2.24×10^{-4}
$d\bar{d} \rightarrow \tilde{u}_1\tilde{u}_1^*$	6.378×10^{-3}	8.07×10^{-4}	6.378×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{u}_3\tilde{u}_3^*$	6.409×10^{-3}	8.07×10^{-4}	6.409×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{u}_4\tilde{u}_4^*$	6.381×10^{-3}	8.07×10^{-4}	6.381×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{u}_5\tilde{u}_5^*$	6.381×10^{-3}	8.07×10^{-4}	6.381×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{u}_6\tilde{u}_6^*$	6.372×10^{-3}	8.06×10^{-4}	6.372×10^{-3}	8.06×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{\chi}_1^0\tilde{\chi}_1^0$	2.702×10^{-6}	6.83×10^{-4}	2.701×10^{-6}	7.2×10^{-4}	4.23×10^{-4}
$d\bar{d} \rightarrow A^0 h$	4.089×10^{-9}	3.46×10^{-4}	4.09×10^{-9}	3.31×10^{-4}	-2.69×10^{-4}
$d\bar{d} \rightarrow \tilde{e}_1\tilde{e}_1^*$	2.056×10^{-5}	4.43×10^{-4}	2.057×10^{-5}	5.33×10^{-4}	-4.04×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_1^0\tilde{\chi}_2^0$	1.152×10^{-5}	7.75×10^{-4}	1.152×10^{-5}	7.75×10^{-4}	-6.25×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_1^0\tilde{\chi}_3^0$	3.651×10^{-6}	3.48×10^{-4}	3.647×10^{-6}	3.65×10^{-4}	1.02×10^{-3}
$d\bar{d} \rightarrow \tilde{\chi}_1^0\tilde{\chi}_4^0$	3.737×10^{-6}	6.65×10^{-4}	3.738×10^{-6}	7.06×10^{-4}	-1.89×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_2^0\tilde{\chi}_2^0$	9.88×10^{-5}	7.66×10^{-4}	9.879×10^{-5}	7.75×10^{-4}	1.14×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_3^0\tilde{\chi}_3^0$	6.981×10^{-8}	3.98×10^{-4}	6.982×10^{-8}	4.7×10^{-4}	-1.19×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_4^0\tilde{\chi}_3^0$	9.747×10^{-5}	1.65×10^{-4}	9.744×10^{-5}	1.69×10^{-4}	2.82×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_2^0\tilde{\chi}_4^0$	3.428×10^{-5}	7.86×10^{-4}	3.43×10^{-5}	7.88×10^{-4}	-5.77×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_1^+\tilde{\chi}_1^-$	3.22×10^{-4}	6.16×10^{-4}	3.223×10^{-4}	6.57×10^{-4}	-1.15×10^{-3}
$d\bar{d} \rightarrow \tilde{\chi}_2^+\tilde{\chi}_2^-$	9.015×10^{-5}	8.52×10^{-4}	9.02×10^{-5}	1.03×10^{-3}	-5.09×10^{-4}
$d\bar{d} \rightarrow \tilde{\chi}_1^+\tilde{\chi}_2^-$	2.413×10^{-5}	5.73×10^{-4}	2.413×10^{-5}	6.36×10^{-4}	-4.14×10^{-6}
$d\bar{d} \rightarrow \tilde{\chi}_1^-\tilde{\chi}_2^+$	2.414×10^{-5}	5.7×10^{-4}	2.414×10^{-5}	6.15×10^{-4}	-9.94×10^{-5}
$d\bar{d} \rightarrow hZ$	3.045×10^{-5}	3.46×10^{-4}	3.046×10^{-5}	3.31×10^{-4}	-2.96×10^{-4}
$d\bar{d} \rightarrow A^0 H$	2.351×10^{-5}	3.46×10^{-4}	2.351×10^{-5}	3.31×10^{-4}	-2.98×10^{-4}
$d\bar{d} \rightarrow H^- H^+$	2.048×10^{-5}	4.4×10^{-4}	2.049×10^{-5}	5.35×10^{-4}	-4.05×10^{-4}
$d\bar{d} \rightarrow \tilde{d}_1\tilde{d}_1^*$	9.535×10^{-2}	3.81×10^{-4}	9.535×10^{-2}	3.81×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{g}\tilde{g}$	6.231×10^{-2}	7.91×10^{-4}	6.232×10^{-2}	8.35×10^{-4}	-1.28×10^{-4}
$d\bar{d} \rightarrow \tilde{u}_2\tilde{u}_2^*$	6.378×10^{-3}	8.07×10^{-4}	6.378×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{d}_2\tilde{d}_2^*$	6.376×10^{-3}	8.07×10^{-4}	6.376×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{d}_3\tilde{d}_3^*$	6.388×10^{-3}	8.06×10^{-4}	6.388×10^{-3}	8.06×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{d}_4\tilde{d}_4^*$	9.539×10^{-2}	3.9×10^{-4}	9.539×10^{-2}	3.9×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{d}_5\tilde{d}_5^*$	6.382×10^{-3}	8.07×10^{-4}	6.382×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{d}_6\tilde{d}_6^*$	6.382×10^{-3}	8.07×10^{-4}	6.382×10^{-3}	8.07×10^{-4}	0.
$d\bar{d} \rightarrow \tilde{g}\tilde{g}$	6.231×10^{-2}	7.91×10^{-4}	6.232×10^{-2}	8.35×10^{-4}	-1.28×10^{-4}
$d\bar{d} \rightarrow gg$	8.496×10^{-1}	3.11×10^{-4}	8.496×10^{-1}	3.11×10^{-4}	0.
$u\bar{u} \rightarrow \tilde{g}\tilde{g}$	6.232×10^{-2}	7.91×10^{-4}	6.233×10^{-2}	8.35×10^{-4}	-1.28×10^{-4}
$gg \rightarrow \tilde{g}\tilde{g}$	9.729×10^{-1}	3.47×10^{-4}	9.729×10^{-1}	3.47×10^{-4}	0.
$\tilde{d}_2\tilde{d}_2^* \rightarrow \tilde{g}\tilde{g}$	2.872	2.71×10^{-3}	2.874	2.48×10^{-3}	-5.92×10^{-4}
$\tilde{d}\tilde{d}_1 \rightarrow \tilde{g}g$	9.16×10^{-1}	3.29×10^{-4}	9.16×10^{-1}	3.29×10^{-4}	0.
$gg \rightarrow \tilde{d}_2\tilde{d}_2^*$	8.595×10^{-3}	7.57×10^{-4}	8.595×10^{-3}	7.57×10^{-4}	0.
$gg \rightarrow \tilde{u}_3\tilde{u}_3^*$	8.789×10^{-3}	7.46×10^{-4}	8.789×10^{-3}	7.46×10^{-4}	0.

$gg \rightarrow b\bar{b}$	4.104×10^{-1}	2.39×10^{-4}	4.104×10^{-1}	2.39×10^{-4}	0.
$gg \rightarrow t\bar{t}$	2.033×10^{-1}	2.84×10^{-4}	2.033×10^{-1}	2.84×10^{-4}	0.
$\tau\bar{\tau} \rightarrow \tilde{e}_1 e_1^*$	1.508×10^{-4}	6.78×10^{-4}	1.508×10^{-4}	7.58×10^{-4}	-5.3×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{e}_2 e_2^*$	1.508×10^{-4}	6.78×10^{-4}	1.508×10^{-4}	7.58×10^{-4}	-5.3×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{e}_3 e_3^*$	3.975×10^{-3}	2.94×10^{-4}	3.977×10^{-3}	3.5×10^{-4}	-3.97×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{e}_4 e_4^*$	1.352×10^{-4}	6.84×10^{-4}	1.352×10^{-4}	7.69×10^{-4}	-1.85×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{e}_5 e_5^*$	1.352×10^{-4}	6.84×10^{-4}	1.352×10^{-4}	7.69×10^{-4}	-1.85×10^{-4}
$\tau\bar{\tau} \rightarrow A^0 h$	1.782×10^{-7}	1.46×10^{-3}	1.786×10^{-7}	1.37×10^{-3}	-2.17×10^{-3}
$\tau\bar{\tau} \rightarrow \tilde{e}_6 \tilde{e}_6$	3.821×10^{-3}	3.9×10^{-4}	3.819×10^{-3}	3.47×10^{-4}	5.53×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{e}_3 \tilde{e}_6$	7.907×10^{-4}	4.31×10^{-4}	7.907×10^{-4}	4.31×10^{-4}	1.85×10^{-10}
$\tau\bar{\tau} \rightarrow \tilde{u}_1 \tilde{u}_1^*$	2.713×10^{-4}	6.1×10^{-4}	2.714×10^{-4}	6.83×10^{-4}	-1.88×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_2 \tilde{u}_2^*$	2.713×10^{-4}	6.1×10^{-4}	2.714×10^{-4}	6.83×10^{-4}	-1.88×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_3 \tilde{u}_3^*$	1.687×10^{-4}	7.23×10^{-4}	1.687×10^{-4}	8.07×10^{-4}	-1.78×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_4 \tilde{u}_4^*$	1.787×10^{-4}	6.85×10^{-4}	1.787×10^{-4}	7.74×10^{-4}	-1.68×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_5 \tilde{u}_5^*$	1.787×10^{-4}	6.85×10^{-4}	1.787×10^{-4}	7.74×10^{-4}	-1.68×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_6 \tilde{u}_6^*$	2.036×10^{-4}	6.48×10^{-4}	2.036×10^{-4}	7.33×10^{-4}	-1.72×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{u}_3 \tilde{u}_6^*$	3.948×10^{-5}	3.02×10^{-4}	3.948×10^{-5}	3.02×10^{-4}	2.71×10^{-8}
$\tau\bar{\tau} \rightarrow \tilde{u}_6 \tilde{u}_3^*$	3.948×10^{-5}	3.02×10^{-4}	3.948×10^{-5}	3.02×10^{-4}	2.71×10^{-8}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0$	6.334×10^{-4}	7.42×10^{-4}	6.34×10^{-4}	8.38×10^{-4}	-8.71×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_2^0$	2.324×10^{-4}	7.51×10^{-4}	2.322×10^{-4}	7.47×10^{-4}	8.05×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_3^0$	1.231×10^{-5}	1.17×10^{-3}	1.232×10^{-5}	9.16×10^{-4}	-8.45×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_4^0$	3.063×10^{-5}	9.43×10^{-4}	3.059×10^{-5}	9.41×10^{-4}	1.11×10^{-3}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_2^0$	4.241×10^{-4}	8.03×10^{-4}	4.232×10^{-4}	7.71×10^{-4}	2.12×10^{-3}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_3^0 \tilde{\chi}_3^0$	1.008×10^{-6}	6.18×10^{-4}	1.007×10^{-6}	6.44×10^{-4}	1.05×10^{-3}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_4^0 \tilde{\chi}_3^0$	1.853×10^{-4}	1.94×10^{-4}	1.853×10^{-4}	1.93×10^{-4}	-4.46×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_4^0$	6.011×10^{-5}	7.15×10^{-4}	$6. \times 10^{-5}$	7.07×10^{-4}	1.73×10^{-3}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-$	1.018×10^{-3}	8.57×10^{-4}	1.018×10^{-3}	9.97×10^{-4}	4.6×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_2^+ \tilde{\chi}_2^-$	5.731×10^{-4}	7.09×10^{-4}	5.732×10^{-4}	7.79×10^{-4}	-2.12×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_2^-$	8.021×10^{-5}	6.56×10^{-4}	8.016×10^{-5}	6.58×10^{-4}	6.6×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{\chi}_1^- \tilde{\chi}_2^+$	8.023×10^{-5}	6.5×10^{-4}	8.016×10^{-5}	6.48×10^{-4}	8.44×10^{-4}
$\tau\bar{\tau} \rightarrow h h$	1.36×10^{-9}	2.09×10^{-3}	1.36×10^{-9}	2.11×10^{-3}	-2.94×10^{-4}
$\tau\bar{\tau} \rightarrow H H$	7.418×10^{-7}	1.81×10^{-3}	7.424×10^{-7}	1.73×10^{-3}	-8.63×10^{-4}
$\tau\bar{\tau} \rightarrow h H$	1.084×10^{-7}	4.38×10^{-4}	1.084×10^{-7}	4.8×10^{-4}	3.23×10^{-4}
$\tau\bar{\tau} \rightarrow h Z$	6.472×10^{-5}	1.56×10^{-3}	6.472×10^{-5}	1.56×10^{-3}	1.55×10^{-7}
$\tau\bar{\tau} \rightarrow h \gamma$	2.55×10^{-6}	2.17×10^{-4}	2.55×10^{-6}	2.17×10^{-4}	0.
$\tau\bar{\tau} \rightarrow A^0 H$	5.283×10^{-5}	3.68×10^{-4}	5.281×10^{-5}	4.09×10^{-4}	2.4×10^{-4}
$\tau\bar{\tau} \rightarrow A^0 Z$	2.661×10^{-3}	1.34×10^{-3}	2.661×10^{-3}	1.34×10^{-3}	0.
$\tau\bar{\tau} \rightarrow A^0 \gamma$	1.957×10^{-4}	2.19×10^{-4}	1.957×10^{-4}	2.19×10^{-4}	0.
$\tau\bar{\tau} \rightarrow H^- W^+$	3.108×10^{-3}	1.42×10^{-3}	3.109×10^{-3}	1.44×10^{-3}	-2.25×10^{-4}
$\tau\bar{\tau} \rightarrow H^- H^+$	1.496×10^{-4}	7.36×10^{-4}	1.496×10^{-4}	8.3×10^{-4}	-6.68×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{d}_1 \tilde{d}_1^*$	1.834×10^{-4}	4.18×10^{-4}	1.834×10^{-4}	4.79×10^{-4}	-6.54×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{d}_2 \tilde{d}_2^*$	1.834×10^{-4}	4.18×10^{-4}	1.834×10^{-4}	4.79×10^{-4}	-6.54×10^{-5}
$\tau\bar{\tau} \rightarrow \tilde{d}_3 \tilde{d}_3^*$	1.479×10^{-4}	4.32×10^{-4}	1.479×10^{-4}	5.27×10^{-4}	-1.42×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{d}_4 \tilde{d}_4^*$	4.468×10^{-5}	6.85×10^{-4}	4.469×10^{-5}	7.74×10^{-4}	-1.57×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{d}_5 \tilde{d}_5^*$	4.468×10^{-5}	6.85×10^{-4}	4.469×10^{-5}	7.74×10^{-4}	-1.57×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{d}_6 \tilde{d}_6^*$	4.183×10^{-5}	7.13×10^{-4}	4.183×10^{-5}	8.02×10^{-4}	-1.13×10^{-4}
$\tau\bar{\tau} \rightarrow \tilde{d}_3 \tilde{d}_6^*$	1.939×10^{-5}	3.03×10^{-4}	1.939×10^{-5}	3.03×10^{-4}	2.06×10^{-8}
$\tau\bar{\tau} \rightarrow \tilde{d}_6 \tilde{d}_3^*$	1.939×10^{-5}	3.03×10^{-4}	1.939×10^{-5}	3.03×10^{-4}	2.06×10^{-8}
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow W^- W^+$	3.247×10^{-4}	2.77×10^{-3}	3.247×10^{-4}	2.77×10^{-3}	3.08×10^{-10}
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow h A^0$	8.048×10^{-5}	5.17×10^{-4}	8.048×10^{-5}	5.17×10^{-4}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow Z Z$	1.439×10^{-4}	2.85×10^{-3}	1.439×10^{-4}	2.85×10^{-3}	1.39×10^{-9}

$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0$	9.93×10^{-6}	8.79×10^{-4}	9.93×10^{-6}	8.79×10^{-4}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_2^0$	7.99×10^{-5}	1.25×10^{-3}	7.99×10^{-5}	1.25×10^{-3}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_3^0 \tilde{\chi}_3^0$	2.664×10^{-2}	1.4×10^{-3}	2.664×10^{-2}	1.4×10^{-3}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_4^0 \tilde{\chi}_4^0$	8.693×10^{-4}	1.42×10^{-3}	8.693×10^{-4}	1.42×10^{-3}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow H A^0$	4.403×10^{-4}	3.14×10^{-4}	4.403×10^{-4}	3.14×10^{-4}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^-$	5.931×10^{-2}	1.55×10^{-3}	5.931×10^{-2}	1.55×10^{-3}	-1.69×10^{-5}
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_2^+ \tilde{\chi}_2^-$	1.562×10^{-2}	1.73×10^{-3}	1.562×10^{-2}	1.73×10^{-3}	0.
$\tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_2^0$	5.636×10^{-5}	9.07×10^{-4}	5.636×10^{-5}	9.07×10^{-4}	0.

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